Yuba river watershed is biologically, environmentally, and socio-economically feasible over the long term.

CALFED Bay-Delta Program

CALFED has funded four ecosystem restoration projects in Feather River and Sutter Basin. One project screened the Browns Valley Irrigation District diversion. Another project developed a watershed plan for the Yuba River.

Linkage to Other Ecological Management Zones

Many of the resource elements in the Feather River/Sutter Basin Ecological Management Zone depend extensively on conditions or elements in other zones. Anadromous fish, for example, are highly migratory and depend on conditions in the mainstem Sacramento River, the Delta, San Francisco Bay, and the nearshore Pacific Ocean. Because these fish are affected by stressors throughout their range, such as unscreened diversions, toxic contaminants, degraded water quality, and harvest, restoring populations in the Feather River/Sutter Basin Ecological Management Zone will require corresponding efforts in other zones.

Reducing or eliminating stressors in the downstream Ecological Management Zones and improving or recreating habitat in those zones are important steps in restoring healthy fish, wildlife, and plant communities in the Feather River/Sutter Basin Ecological Management Zone. Efforts in the Sutter Basin, particularly those relating to the Sutter Bypass and Butte Slough, will greatly benefit the other Ecological Management Zones and units of the upper Sacramento River.

Restoration Targets and Programmatic Actions

Ecological Processes

Central Valley Streamflows

Target 1: More closely emulate the seasonal streamflow pattern in the Feather River by providing March flow events of 4,000 to 6,000 cfs in dry years, 6,000 to 8,000 cfs in below-normal years, and 8,000 to 10,000 cfs in above-normal years. In addition, evaluating the minimum flows recommended by DFG (1993) will provide a basis to refine the flow needs in the Feather River better. Flow events will be provided only if they are less than or equal to Oroville Reservoir inflow (◆◆).

Programmatic Action 1A: Develop a cooperative program to evaluate the benefits of supplemental Feather River flows to ecological processes and riparian and riverine aquatic habitats.

Programmatic Action 1B: Evaluate alternative flow schedules in the Feather River to optimize the ecological benefits for fish and plant communities and ecological processes such as stream meander, sediment transport, and temperature control.

Target 2: Evaluate the potential benefits to increased natural production of salmon and steelhead in the Feather River of releasing 2,500 cfs from Oroville Dam during September through May and 1,100 cfs during June through August in wet and normal years, and 1,700 cfs during September through May and 800 cfs during June through August in dry years (◆◆).

Programmatic Action 2A: Develop a cooperative program to supplement Feather River flows with water acquired from new water sources, water transfers, and willing sellers in accordance with applicable guidelines or negotiated agreements.

Target 3: Supplement flows in the Yuba River with March flow events of 2,000 to 3,000 cfs in dry years and 3,000 to 4,000 cfs in normal years to improve conditions for all chinook salmon, steelhead, and American shad life stages. In addition, provide minimum flows recommended at Marysville by DFG (1993). See table below. Flows will be provided only if inflow to Englebright and New Bullards Bar Reservoirs is sufficient to meet the flow requirements (◆◆).

Minimum Streamflow Recommendations for Yuba River at Marysville

Period	Flow in All Water-Year Types
October 1-March 31	600-700 cfs
April 1-June 30	1,000 cfs minimum
July 1-September 30	450 cfs

PROGRAMMATIC ACTION 3A: Supplement flows in the Yuba River below Englebright Dam with water acquired from new water sources, water transfers, and willing sellers, consistent with applicable guidelines or negotiated agreements to provide flows recommended by DFG (1993) to improve conditions for all chinook salmon and steelhead life stages. See table above.

TARGET 4: Supplement flows in the Bear River to improve conditions for all chinook salmon and steelhead life stages. Provide a flow event of 300 to 500 cfs in dry years. See table below for recommended minimum streamflows (◆◆).

Minimum Streamflow Recommendations for Bear River

Month	Flows (cfs)
October 1-14	100
October 15-December 15	250
January-March	250
April-June	250
July-September	10

PROGRAMMATIC ACTION 4A: Supplement flows in the Bear River with water acquired from new water sources, water transfers, and willing sellers consistent with applicable guidelines or negotiated agreements to provide flows that will improve conditions for all chinook salmon and steelhead life stages.

RATIONALE: *The proposed March supplemental flows were selected as a representative value for impact analysis in the Programmatic EIS/EIR. Throughout the ERP, the need to determine optimal streamflow for ecological processes, habitats, and species is repeated. The issues of supplemental flows are complex in term of ecosystem improvements. The frequency, magnitude, duration, timing and rate of change of streamflows that form channels, create and maintain riparian habitat (including all species of vegetation), and promote all life stages of the various aquatic species dependent on a particular stream will never occur within a single year. An optimal flow regime will have to vary, perhaps significantly, from year to year. The supplemental flow recommendations will be an intensive exercise in adaptive management and must be based on credible scientific underpinnings.*

The streams in the Feather River/Sutter Basin Ecological Management Zone provide extremely valuable habitat for spring-run chinook salmon and steelhead trout. Key benefits of streamflow in this Ecological Management Zone are successful upstream of adult fish passage and downstream passage of juvenile fish. In addition, flow drives many ecological functions and processes linked to stream-channel morphology, riparian communities, and fish habitat. The best flow schedule for providing maximum ecological benefits in the Feather River has not been agreed upon. The California Department of Fish and Game (1993) recommended the following flows and temperatures below Thermalito Afterbay:

Period	Streamflow (cfs)	Temperature
Jan-Apr	2,000	56°F
May 1 - 15	3,000	60
May 16 - June 15	4,000	60
June 16 - Oct 15	1,000	NF
Oct 16 - Dec 31	1,700	56

The increased flow in the DFG recommendation is partially designed to provide a large flow for American shad spawning. The temperature recommendation, however, is too low for shad as they require a spawning temperature about 5 ^{0}F higher than recommended.

Technical agreement on Feather River flows and temperatures has not been reached. This is an area that needs to be addressed by the CALFED approach to adaptive management. Additional monitoring and/or research may be required to develop consensus on these issues. The CALFED approach also goes beyond the flow and temperature requirements of anadromous fish by also including the flows needed for coarse sediment transport, overbank flooding, and riparian maintenance and regeneration. The recommended flow targets provide a basis for on-going and future evaluations using adaptive management as a tool to reach agreement.

Supplementing flows on the Yuba River by acquisition of water from willing sellers depends on whether or not there are any willing sellers. Findings from a detailed hydrologic and operations assessment

of the Yuba River system to develop water-year-type-specific instream flow recommendations indicate that, with the exception of wet years, insufficient water would be available within the system always to meet the recommended flows (Beak 1996). In years when flow augmentation is required, a decision will have to be made regarding use of acquired water in the spring to either meet DFG's recommendation of 1,000 cfs at Marysville during the April-June period, or to use this water to 1) provide higher flows and, therefore, greater thermal protection to steelhead during July-September, or 2) supplement flows during the October-December period to benefit fall-run chinook salmon spawning.

Studies conducted in the lower Yuba River during 1976-1978 revealed that the lower Yuba River is not a season-long nursery area for American shad (Meinze 1979). That may reflect drought condition during part of the study period but the study did reveal that newly hatched shad fry are rapidly transported downstream and into the Feather River. Larvae are swept out by currents before they grow large enough to maintain their position in the river. Juvenile shad spend several weeks to several months in the Feather and Sacramento rivers and in the Delta, which is considered the primary rearing habitat for American shad (Painter et al. 1977, Painter et al. 1979, Meinze 1979, SWRCB 1992). Consequently, higher spring flows in the lower Yuba River may provide minimal increased benefits for young shad.

COARSE SEDIMENT SUPPLY

TARGET 1: Maintain existing erosion and gravel recruitment levels in tributaries that sustain an adequate level of gravel recruitment, or restore desirable levels by directly manipulating and augmenting gravel supplies where the natural fluvial process has been interrupted by dams or other features that retain or remove the gravel supply (◆◆).

PROGRAMMATIC ACTION 1A: Evaluate spawning gravel quality in areas used by chinook salmon and steelhead in the Feather River. If indicated, renovate or supplement gravel supplies to enhance substrate quality by importing 4,000 to 8,000 tons of additional gravel below the hatchery as conditions require.

PROGRAMMATIC ACTION 1B: Evaluate spawning gravel quality in areas used by chinook salmon and steelhead in the Yuba River. If indicated, renovate or supplement gravel supplies to enhance substrate quality.

PROGRAMMATIC ACTION 1C: Evaluate the quality of spawning gravel in areas used by chinook salmon and steelhead in the Bear River. If indicated, renovate or supplement gravel supplies to enhance substrate quality

RATIONALE: *Sediment transport is the process whereby flows carry away finer sediments that fill gravel interstices (i.e., spaces between cobbles). Gravel cleansing is the process whereby flows transport, grade, and scour gravel. Gravel transport and cleansing, by flushing most fines and moving bedload, are important processes to maintain the amount and distribution of spawning habitat in the Sacramento-San Joaquin River basin. Human activities have greatly reduced or altered these processes. Opportunities to maintain and restore these processes include changing water flow, sediment supplies, and basin geomorphology; removing stressors; or manipulating channel features and stream vegetation directly. Gravel deposits in Feather River/Sutter Basin Ecological Management Zone streams are essential to maintain spring- and fall-run chinook salmon, steelhead trout, and other resident native fish spawning and rearing habitats. Although additional evaluations are required to define the magnitude of flows required to move coarse sediments in each of the streams in this ecological management zone better, it appears that flows exceeding 20,000 cfs in the Feather River are probably sufficient to achieve this important ecological event.*

Opportunities to maintain and restore gravel recruitment include manipulating natural processes and controlling or managing environmental stressors that adversely affect recruitment.

STREAM MEANDER

TARGET 1: Preserve and expand the stream-meander belts in the Feather, Yuba, and Bear Rivers by adding a cumulative total of 1,000 acres of riparian lands to the meander zones (◆◆◆).

PROGRAMMATIC ACTION 1A: Acquire riparian and meander-zone lands by purchasing them directly or acquiring easements from willing sellers, or

provide incentives for voluntary efforts to preserve and manage riparian areas on private land.

PROGRAMMATIC ACTION 1B: Build local support for maintaining active meander zones by establishing a mechanism whereby property owners would be reimbursed for lands lost to natural meander processes.

PROGRAMMATIC ACTION 1C: Develop a cooperative program to improve opportunities for natural meander by removing riprap and relocating other structures that impair stream meander.

RATIONALE: *Preserving and improving the stream-meander belts in the Feather River/Sutter Basin Ecological Management Zone will ensure that this important natural process is maintained. Typically, these reaches are important for spawning and rearing salmon and steelhead. A natural meander process will provide near-optimal habitat for spawning (through gravel recruitment), rearing (channel configuration, cover, and foodweb), and migration. There is limited potential for natural channel migration in narrowly leveed sections. Overall, the program must be consistent with flood control requirements and in the longer term, should reduce need for future flood control efforts by using natural system resilience and flood control characteristics.*

NATURAL FLOODPLAIN AND FLOOD PROCESSES

TARGET 1: Restore and improve opportunities for rivers to flood their floodplain seasonally (◆).

PROGRAMMATIC ACTION 1A: Conduct a feasibility study to construct setback levees in the Feather, Yuba, and Bear lower river floodplains.

PROGRAMMATIC ACTION 1B: Restore, as needed, stream channel and overflow basin configurations within the floodplain.

PROGRAMMATIC ACTION 1C: Minimize effects of permanent structures, such as bridges and diversion dams, on floodplain processes.

PROGRAMMATIC ACTION 1D: Develop a floodplain management plan for the Feather River.

PROGRAMMATIC ACTION 1E: Develop a floodplain management plan for the Yuba River.

PROGRAMMATIC ACTION 1F: Develop a floodplain management plan for the Bear River.

PROGRAMMATIC ACTION 1G: Develop a floodplain management plan for the Sutter Basin and Sutter Bypass.

RATIONALE: *Setback levees will provide greater floodplain inundation, room for stream meander, and more riparian forest and seasonal wetland habitats along the lower rivers. Channel configuration adjustments may be necessary to accelerate natural floodplain habitat restoration and to restore and maintain configurations that may not occur naturally due to remaining constraints from new setback levees. Permanent structures, such as bridges and diversions dams, can interrupt and impair natural floodplain processes and habitat development and succession. Thus, it may be necessary to remove or rebuild some structures or require continuing maintenance or mitigations to minimize their effects.*

CENTRAL VALLEY STREAM TEMPERATURES

TARGET 1: Improve water quality conditions in the Feather, Yuba, and Bear rivers to benefit anadromous fish (◆◆).

PROGRAMMATIC ACTION 1A: Develop and use a temperature model as a tool for managing the Feather River.

PROGRAMMATIC ACTION 1B: Maintain a daily average water temperature of 60°F in the low-flow section of the Feather River from June 1 through September 30 to benefit over-summering steelhead juveniles.

PROGRAMMATIC ACTION 1C: Develop a cooperative program to identify and remove physical and water quality barriers in the Feather River that impede access for white and green sturgeon to spawning habitat, or facilitate passage around these barriers.

PROGRAMMATIC ACTION 1D: Develop a cooperative program to maintain mean daily water temperatures below 65°F for at least 1 month from April 1 to June 30 for American shad spawning in the Feather River. This is consistent with actions to protect chinook salmon and, steelhead and, when hydrologic conditions are adequate, to minimize adverse effects on water-supply operations.

PROGRAMMATIC ACTION 1E: Develop a cooperative approach to operating reservoirs in the Yuba River watershed to provide adequate water temperatures for anadromous fish.

PROGRAMMATIC ACTION 1F: Evaluate whether improving water temperature control with shutter configuration and present coldwater pool management at New Bullards Bar Dam on the Yuba River are effective. Modify the water release outlets at Englebright Dam if these improvements are effective.

PROGRAMMATIC ACTION 1G: Maintain a daily average water temperature of 60°F from Englebright Dam to Daguerre Point Dam in the Yuba River from June 1 through September 30 to benefit over-summering steelhead juveniles.

PROGRAMMATIC ACTION 1H: Develop a cooperative program to maintain mean daily water temperatures below 65°F for at least 1 month from April 1 to June 30 for American shad spawning in the Yuba River. This is consistent with actions to protect chinook salmon and steelhead and, when hydrologic conditions are adequate, to minimize adverse effects on water-supply operations.

PROGRAMMATIC ACTION 1I: Develop a cooperative approach to providing adequate water temperatures in the Bear River (see following table) for all chinook salmon and steelhead life stages.

RATIONALE: *Aquatic species have very specific water temperature requirements that vary by stage in their life cycles. Water temperatures are typically high during the late summer and early fall, when water management flexibility below the major reservoirs is typically limited. Water temperatures should be addressed through integrated water and temperature management programs that seek to conserve cool water reservoir pools for release later in the summer and by investigating feasibility of modifying water release outlets on existing dams to provide a greater ability to utilize the cold water in the reservoir fully.*

Operating to provide specific water temperatures at the appropriate times in systems where aquatic resources have differing temperature requirements can be difficult. In situations where water temperature requirements may conflict, water temperature operations should first address the needs of listed species, then native species, and then introduced species. On the Feather and Yuba rivers, the water temperature requirements of anadromous salmonids (chinook salmon and steelhead) have priority. After their temperature needs are met, then the temperature requirements of American shad can be addressed.

Required Water Temperatures in the Bear River for Chinook Salmon and Steelhead

Month	Flows (cfs)	Temperature (°F)	
		Wheat-land	Highway 70
October 1-14	100	60	60
October 15-December 15	250	58	57
January-March	250	56	57
April-June	250	60	60
July-September	10	65	65

HABITATS

SEASONAL WETLANDS

TARGET 1: Assist in protecting 500 acres of existing seasonal wetland habitat through fee acquisition or perpetual easements consistent with the goals of the Central Valley Habitat Joint Venture and the North American Waterfowl Management Plan (◆◆).

PROGRAMMATIC ACTION 1A: Develop and implement a cooperative program to improve management of 500 acres of existing, degraded seasonal wetland habitat in the Sutter Bypass Ecological Management Unit.

TARGET 2: Develop and implement a cooperative program to enhance 3,090 acres of existing public and private seasonal wetland habitat consistent with the goals of the Central Valley Habitat Joint Venture and the North American Waterfowl Management Plan (◆◆).

PROGRAMMATIC ACTION 2A: Restore and manage seasonal wetland habitat throughout the Sutter Bypass Ecological Management Unit.

RATIONALE: *Restoring seasonal wetland habitats along with aquatic, permanent wetland, and riparian*

habitats is an essential element of the restoration strategy for the Feather River/Sutter Basin Ecological Management Zone. Restoring these habitats will also reduce the amount and concentrations of contaminants that could interfere with restoring the ecological health of the aquatic ecosystem. Seasonal wetlands support a high production rate of primary and secondary food species and large blooms (dense populations) of aquatic invertebrates.

Wetlands that are dry in summer are also efficient sinks for the transformation of nutrients and the breakdown of pesticides and other contaminants. The roughness of seasonal wetland vegetation filters and traps sediment and organic particulates. Water flowing out from seasonal wetlands is typically high in foodweb prey species concentrations and fine particulate organic matter that feed many Delta aquatic and semiaquatic fish and wildlife. To capitalize on these functions, most of the seasonal wetlands of the Colusa Basin Ecological Management Zone should be subject to periodic flooding and overland flow from river floodplains.

Riparian and Riverine Aquatic Habitats

Target: Provide conditions for riparian vegetation growth along river sections in the Feather River/Sutter Basin Ecological Management Zone (◆◆).

Programmatic Action 1a: Purchase streambank conservation easements from willing sellers or establish voluntary incentive programs to improve salmonid habitat and instream cover along the Yuba River.

Programmatic Action 1b: Evaluate the benefits of restoring stream-channel and riparian habitats on the Yuba River, including creating side channels to serve as spawning and rearing habitats for salmonids.

Programmatic Action 1c: Purchase streambank conservation easements from willing sellers or establish voluntary incentive programs to improve salmonid habitat and instream cover along the Feather River.

Programmatic Action 1d: Purchase streambank conservation easements from willing sellers or establish voluntary incentive programs to improve salmonid habitat and instream cover along the Bear River.

Rationale: *Many wildlife species, including several listed as threatened or endangered under the State and federal Endangered Species Acts and several special-status plant species in the Central Valley, depend on or are closely associated with riparian habitats. Riparian habitats support a greater wildlife species diversity than all other habitat types in California. Riparian habitat degradation and loss has substantially reduced the habitat area available for associated wildlife species. Loss of this habitat has reduced water storage, nutrient cycling, and foodweb support functions.*

Improving low- to moderate-quality shaded riverine aquatic habitat will benefit juvenile chinook salmon and steelhead by improving shade, cover, and food. Wildlife in this Ecological Management Zone will also benefit from improved habitat. Protecting and improving shaded riverine aquatic habitat may involve changes in land use that will require the consensus of local landowners and local, State, and federal agencies. Limitations on land suitable or available for restoration will require establishing priorities, with efforts directed at acquiring high-priority, low-cost sites first.

Freshwater Fish Habitat and Essential Fish Habitat

Target 1: Maintain and improve existing freshwater fish habitat and essential fish habitat through the integration of actions described for ecological processes, habitats, and stressor reduction or elimination (◆◆).

Programmatic Actions: No additional programmatic actions are recommended.

Rationale: *Freshwater fish habitat and essential fish habitat are evaluated in terms of their quality and quantity. Actions described for ecological processes, stressor reduction, and riparian and riverine aquatic habitat should suffice to maintain and restore freshwater fish habitat and essential fish habitat. For example, maintaining freshwater and essential fish habitats is governed by actions to maintain streamflow, improve coarse sediment supplies, maintain stream meander, maintain or restore connectivity of the Feather, Yuba, and Bear rivers*

and their floodplains, and in maintaining and restoring riparian and riverine aquatic habitats.

AGRICULTURAL LANDS

TARGET 1: Cooperatively manage 57,578 acres of agricultural lands consistent with the objectives of the Central Valley Habitat Joint Venture and the North American Waterfowl Management Plan (◆◆).

PROGRAMMATIC ACTION 1A: Increase the area of rice fields and other crop lands flooded in winter and spring to provide high-quality foraging habitat for wintering and migrating waterfowl and shorebirds and associated wildlife.

RATIONALE: *Following the extensive loss of native wetland habitats in the Central Valley, some wetland wildlife species have adapted to the artificial wetlands of some agricultural practices and have become dependent on these wetlands to sustain their populations. Agriculturally created wetlands include rice lands; fields flooded for weed and pest control; stubble management; and tailwater circulation ponds.*

Managing agricultural lands to increase forage for waterfowl and other wildlife will increase the survival rates of overwintering wildlife and strengthen them for migration, thus improving breeding success (Madrone Associates 1980)

Creating small ponds on farms with nearby waterfowl nesting habitat but little brood habitat will increase production of resident waterfowl species when brood ponds are developed and managed properly. Researchers and wetland managers with the DFG, U.S. Fish and Wildlife Service and the California Waterfowl Association have found that well managed brood ponds produce the high levels of invertebrates needed to support brooding waterfowl. Other wildlife such as the giant garter snake will also benefit. Restoring suitable nesting habitat near brood ponds will increase the production of resident waterfowl species.

Restoring nesting habitat, especially when it is near brood ponds, will increase the production of resident waterfowl species. When the restored nesting habitat is properly managed, large, ground predators are less effective in preying on eggs and young of waterfowl and other ground nesting birds. Managing agricultural lands to increase forage for waterfowl and other wildlife will increase the overwinter survival rates of wildlife and strengthen them for migration, thus improving breeding success (Madrone and Assoc. 1980)

REDUCING OR ELIMINATING STRESSORS

WATER DIVERSIONS

TARGET 1: Improve the survival of juvenile anadromous fish in the Yuba River by installing, upgrading, or replacing fish screens (◆◆◆).

PROGRAMMATIC ACTION 1A: Develop a cooperative program to upgrade or construct screens that meet current Department of Fish and Game and National Marine Fisheries Service screening standards at the Hallwood-Cordua and Brophy-South Yuba Canal water diversion, and other unscreened diversions on the Yuba River.

TARGET 2: Improve the survival of juvenile anadromous fish in the Bear River by installing, upgrading, or replacing fish screens (◆◆◆).

PROGRAMMATIC ACTION 2A: Develop a cooperative program to evaluate and screen diversions in the Bear River to protect all anadromous fish life stages.

TARGET 3: Improve the survival of juvenile anadromous fish in the Feather River by installing, upgrading, or replacing fish screens (◆◆◆).

PROGRAMMATIC ACTION 3A: Develop a cooperative program to evaluate and screen diversions in the Feather River to protect all anadromous fish life stages.

RATIONALE: *Water diversion, storage, and release in the watershed directly affect fish, aquatic organisms, and nutrient levels in the system and indirectly affect habitat, foodweb production, and species abundance and distribution. Unscreened diversions cause direct mortality to young fish; the level of mortality is likely influenced by the number of young fish present, diversion size, and diversion timing.*

The fish screens on the water diversions at Daguerre Point Dam on the Yuba River (Hallwood-Cordua and Brophy-South Yuba Canal) are inadequate and do not meet current DFG or NMFS screening criteria

(DFG 1991). The Hallwood-Cordua Fish Screening Facility is funded and staffed by DFG, but because of limited funding, DFG does not operate the facility after the peak of chinook salmon emigration has occurred (sometime in June). Unscreened diversions continue throughout the summer and fall, and significant numbers of juvenile steelhead are entrained and lost. The Brophy-South Yuba diversion utilizes a rock levee to prevent fish from entering the diversion, however, the levee has been shown to be permeable to small fish even when the diversion is not operating, and significant numbers of juvenile chinook salmon are entrained (DFG 1991). Fully-functioning fish screens that meet current criteria and are adequately funded, staffed, and operated throughout the irrigation season need to be implemented at both diversions.

DAMS AND OTHER STRUCTURES

TARGET 1: Increase adult and juvenile anadromous fish passage in the Yuba River by providing access to 100% of the available habitat below Englebright Dam (◆◆◆).

Programmatic Action 1a: Develop a cooperative program to improve anadromous fish passage in the Yuba River by removing dams or constructing fish ladders, providing passage flows, keeping channels open, eliminating predator habitat at instream structures, and constructing improved fish bypasses at diversions.

PROGRAMMATIC ACTION 1B: Facilitate passage of spawning adult salmonids in the Yuba River by maintaining appropriate flows through the fish ladders or modifying the fish ladders at diversion dams.

TARGET 2: Increase the number of naturally produced chinook salmon and steelhead in the Yuba River drainage and contribute to each species long-term sustainability (◆).

PROGRAMMATIC ACTION 2A: Conduct a cooperative study to determine if introduction of wild chinook salmon and steelhead to the Upper Yuba River watershed is biologically, environmentally, and socio-economically feasible over the long term.

TARGET 3: Improve chinook salmon and steelhead passage in the Bear River by providing access to 100% of the available habitat below the SSID diversion dam (◆◆).

PROGRAMMATIC ACTION 3A: Improve chinook salmon and steelhead passage in the Bear River by negotiating with landowners to remove or modify culvert crossings on the Bear River.

RATIONALE: *Dams and their associated reservoirs block fish movement, alter water quality, remove fish and wildlife habitat, and alter hydrologic and sediment processes. Other structures may block fish movement or provide habitat or opportunities for predatory fish and wildlife, which could be detrimental to fish species of special concern.*

It is estimated that 82% to 95% of historical salmon and steelhead spawning and rearing habitat in the Central Valley has been lost due to impassable dams (Reynolds et al. 1993; Yoshiyama 1996). Perhaps the greatest potential for anadromous fish restoration in the Central Valley can be realized by reestablishing access to some of these former habitats, especially for those fish that are dependent upon habitat in mid- to upper-elevation stream reaches, such as steelhead and spring-run chinook salmon. Restoring access at Englebright Dam would allow salmon and steelhead to utilize a considerable amount of historical habitat in the Yuba River system, primarily in the South and Middle forks, and would have a substantial effect on restoration on a basin-wide level. Providing access to historical habitats could also reduce the reliance on low-elevation, valley-floor reaches that require large amounts of water to maintain suitable temperatures, thus could potentially reduce overall water costs for anadromous fish restoration. Compared to other major Central Valley tributaries, the Yuba River has greater potential than most to reestablish access to a substantial amount of former habitat. To resolve issues related to introducing anadromous fish to the watershed above Englebright Dam on the Yuba River, the Upper Yuba River workgroup has identified six key issues for feasible study. These issues include 1) condition of upstream habitat for anadromous fish, 2) affects of reoperating or modifying Englebright Dam on the condition of downstream habitat and fisheries, 3) economic effects and social impacts, 4) impact to water supplies, 5) impact to downstream flood control, and 6) quantity of sediments and heavy metals trapped by the dam.

HARVEST OF FISH AND WILDLIFE

TARGET 1: Develop harvest management strategies that allow wild, naturally produced fish

spawning populations to attain levels that make full use of existing and restored habitat, and focus harvest on hatchery-produced fish (◆◆◆).

PROGRAMMATIC ACTION 1A: Control illegal harvest by increasing enforcement efforts.

PROGRAMMATIC ACTION 1B: Develop harvest management plans with commercial and recreational fishery organizations, resource management agencies, and other stakeholders to meet target levels.

PROGRAMMATIC ACTION 1C: Reduce harvest of wild, naturally produced steelhead populations, by continuing to mark all hatchery-reared fish and continuing to institute selective harvesting.

PROGRAMMATIC ACTION 1D: Evaluate a marking and selective fishery program for chinook salmon.

RATIONALE: *Restoring and maintaining chinook salmon and steelhead populations to levels that take full advantage of habitat may require restricting harvest during and after the recovery period. Involving the various stakeholder organizations should help ensure a balanced and fair harvest allocation. Target population levels may preclude existing harvest levels of wild, naturally produced fish. For populations supplemented with hatchery-reared fish, selective harvesting may be necessary to limit wild fish harvest while harvesting hatchery-produced fish to reduce their potential to disrupt the genetic integrity of wild populations. The Fish and Game Commission recently adopted DFG recommendations to establish a selective fishery for hatchery steelhead and to reduce incidental hooking of wild steelhead on all Central Valley streams.*

ARTIFICIAL PROPAGATION OF FISH

TARGET 1: To protect naturally produced salmon and steelhead, minimize the likelihood that hatchery-reared salmon and steelhead produced in the Feather River Hatchery will stray into non-natal streams (◆◆◆).

PROGRAMMATIC ACTION 1A: Develop a cooperative program to evaluate the benefits of stocking hatchery-reared salmon and steelhead in the Feather River. Stocking levels may be reduced in years when natural production is high.

TARGET 2: Reduce superimposition of chinook redds in the low flow section of the Feather River (◆).

PROGRAMMATIC ACTION 2A: Develop a cooperative program to evaluate alternative means of reducing the number of spawners in the upper section and increasing the number of spawners in the high flow section below Thermalito.

TARGET 3: Limit hatchery stocking if populations of salmon or steelhead can be sustained by natural production (◆◆◆).

PROGRAMMATIC ACTION 3A: Augment fall-run chinook salmon and steelhead populations only when alternative measures are deemed insufficient to provide population recovery.

TARGET 4: Minimize further threats of hatchery-produced fish interbreeding with wild chinook salmon and steelhead stocks (◆◆◆).

PROGRAMMATIC ACTION 4A: Adopt methods for selecting spawning adults for the hatchery from an appropriate cross section of the adult population available to the hatchery.

RATIONALE: *In watersheds such as the Sacramento River and Feather River, where dams and habitat degradation have limited natural spawning, hatchery supplementation may be necessary to sustain fishery harvest at former levels and to maintain a wild or natural spawning population during adverse conditions, such as droughts. Hatchery augmentation, however, should be limited to protect recovery and maintain wild populations. Hatchery-reared salmon and steelhead may directly compete with and prey on wild salmon and steelhead. Hatchery-produced fish may also threaten the genetic integrity of wild stocks by interbreeding with wild fish. Although irreversible contamination of wild stocks has taken place, additional protective measures would minimize further degradation of genetic integrity. Development on the Sacramento and Feather Rivers might necessitate stocking of chinook salmon and steelhead to rebuild and maintain stocks that will sustain sport and commercial fisheries.*

Superimposition of chinook salmon redds in the low flow section of the Feather River is a problem that reduces the success of naturally spawning fish. The mechanisms leading to overuse of the low flow (upper) section of the Feather River are poorly understood. Potential causes may be linked to

hatchery release practices such as trucking to distant release sites, differing flows between the low flow and high flow stream reaches, or genetic history of fish using the upper section. Spring-run chinook have adapted to moving further upstream than their fall-run counterparts. The fall spawning chinook in the Feather River are know to by introgressed with spring-run which may provide one avenue of research to determine why the upper section is over-utilized by spawners while high quality spawning gravel in the high flow section is highly underutilized.

STRANDING

TARGET 1: Reduce or eliminate the stranding of juvenile chinook salmon on floodplains, shallow ponds, and levee borrow areas (◆◆).

PROGRAMMATIC ACTION 1A: Conduct surveys of stranding in the Feather River under a range of flow conditions and develop recommendations to resolve the problem.

PROGRAMMATIC ACTION 1B: Conduct surveys of stranding in the Sutter Bypass under a range of flow conditions and develop recommendations to resolve the problem.

RATIONALE: *Under many flow conditions, stranding is likely a minimal problem. However, under conditions in which rivers reach high flows and flow is diverted into the flood bypasses, and then flow quickly recede, stranding is likely a serious problem. Timing also plays a important role in determining the severity of the problem. Flood plain inundation prior to young salmon emerging is less of a problem that inundation after most of the fry have emerged.*

REFERENCES

Beak (Beak Consultants Incorporated) 1996. Anadromous fish enhancement actions recommended for the lower Yuba River. Prepared by Beak Consultants Inc. In association with Bookman-Edmonston Engineering, Inc. Prepared for the Yuba County Water Agency, Marysville, California. Draft report dated July 1996.

Brown. R. and S. Green. 1997. An evaluation of the Feather River Hatchery as mitigation for construction of the California State Water Project's Oroville Dam. California Department of Water Resources.

California Department of Fish and Game. 1993. Restoring Central Valley Streams: a plan for action. November 1993.

California Dept. of Fish and Game. 1991. Lower Yuba River fisheries management plan. Evaluation Rpt. No. 91-1.

Central Valley Habitat Joint Venture. 1990. Central Valley Habitat Joint Venture Implementation Plan, a component of the North American Waterfowl Management Plan. February 1990.

Jones and Stokes Associates 1990. 1009 field investigations of Yuba River American shad (JSA 90-098). Prepared by W.T. Mitchell and P.L. Dunn. Sacramento, California. Prepared for the Yuba County Water Agency.

Madrone Associates. 1980. Sacramento-San Joaquin Delta wildlife habitat protection and restoration plan. Prepared for the California Department of Fish and Game and U.S. Fish and Wildlife Service.

Meinze. M. 1979. American shad, Alosa sapidissima, sport fishery in the Sacramento river system, 1976-1978: catch and effort. California Department of Fish and Game, Anadromous Fisheries Branch Administrative Report Number 81-1. 19 p.

Moyle, P.B., and J.P. Ellison. 1991. A conservation oriented classification system for the inland waters of California. California Fish and Game 77(4): 161-180.

National Marine Fisheries Service. 1998. Draft proposed recommendations for amendment 14 to the Pacific Coast salmon plan for essential fish habitat. March 26, 1998.

Painter, R.E., L.H. Wixom, and M. Meinze. 1979. American shad management plan for the Sacramento River drainage. Final Report, Job No. 5, California Department of Fish and Game. Anadromous Fisheries Conservation Act, AFS-17. 22 p.

Painter, R.E., L.H. Wixon, and S.W. Taylor. 1977. An evaluation of fish populations and fisheries in the post-Oroville Project Feather River: a report submitted to the Department of Water